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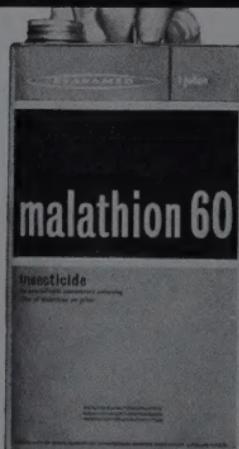
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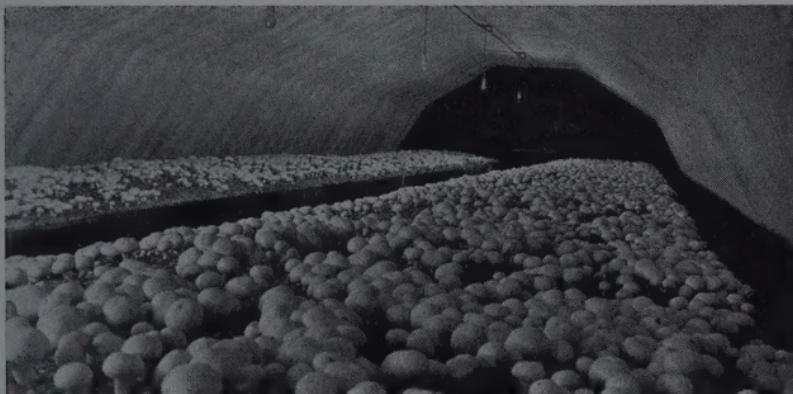
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EDITORIAL

WHY NOT MUSHROOMS?

The Government's £7½ million grant-aid scheme for horticulture has been flatly rejected by the horticultural industry as a replacement for the industry's application for increased tariffs on a number of horticultural products and there may very well be much substance in the question, asked in the House by Mr. R. H. Turton, the Conservative member for Thirsk and Malton. He asked, quite simply, if the decision to reject the application was made to please the Dutch vegetable growers?

There seems little doubt that the application for increased tariffs was made on solid foundations and with the backing of the horticultural industry in general and the stinging blow administered by the Government has caused widespread resentment.

If the resentment can be the means of welding the industry into a unified whole—and certainly the NFU is giving a spirited lead in the matter—then the overall result of the Government's refusal may well prove to be the ultimate benefit of the industry. What is required is unity, and if adversity cannot bring this about nothing can.

Mushroom growers may perhaps wonder why their commodity did not figure in the demand for increased protection. The reason, quite simply, is that at the moment, there is no evidence of a rise in mushroom imports, excluding of course those from Eire which country still enjoys the best of both worlds. It remains an unfortunate fact that until facts and figures are produced to show that imports of mushrooms are affecting the very existence of U.K. growers the Ministry refuses to take action. In every other facet of life, business or private, this waiting for trouble to hit you, without taking any precautions, would be condemned as criminal folly. In the game of politics it would seem to be a virtue. Truth is, so often, stranger than fiction.

WRA

MUSHROOM STRAINS

By C. Riber Rasmussen

Director of Mushroom Research in Denmark

The following data is only a few of many which could be discussed in relation to mushroom strain problems. Some of them are proved on an experimental scale, some are more or less hypothetical and a few of them guess-work, but I hope logical guess-work. Due to the restricted length of this article, many of the problems cannot be fully discussed.

It must just be mentioned that because some persons in the mushroom industry would consider it unfair to mention strains by their trade names these are omitted, but upon request the names will be sent to individuals.

Do the different mushroom strains vary in cropping yield?

Every experienced mushroom grower realises that different mushroom strains vary in colour, shape and ability to produce high yields. It is also known of course that the yield with the same strain varies from crop to crop. In many cases this is without doubt due to general growing conditions, although the possibility cannot be excluded that it could also be due to alterations in the given strain itself.

In order to investigate the yielding capacity of different strains an extensive trial was conducted by the Danish Mushroom Research Station and also at four individual mushroom farms in 1954. Mushroom spawn producers in Europe were requested to offer a number of cartons of brown strains which they considered suitable for good general growing conditions. Seven different strains were tested. The results are shown in Table 1, and it is obvious that these seven strains vary greatly in yield.

TABLE 1
Mushroom Strain Experiments
Kilos per sq. meter in 90 picking days

Strain No.	Grower 1	Grower 2	Grower 3	Grower 4	Average yield
1	11.7	20.2	12.9	21.1	16.5
2	14.5	15.8	12.3	17.7	15.1
3	11.7	14.1	8.8	18.5	13.3
4	8.2	10.3	7.4	14.4	10.1
5	7.3	10.1	9.9	13.0	10.1
6	7.6	9.1	9.5	10.4	9.2
7	6.5	8.4	9.0	15.4	9.8
Average yields for all strains	9.6	12.6	10.0	15.8	

It can also be seen that the yield varied greatly from one farm to another with the same strain, but it is interesting to note that the strains producing the highest average yields were also in general the

highest producers on the individual farms. (These trials, as the best strains came from abroad, led among other things to a reduction of the previous heavy duty on imported spawn.)

The variation in yield with the same strain is undoubtedly due to the growing conditions, but it can also be concluded that some strains are more tolerant in their requirements than others. It must however be added, that the high yielding strain does not always produce first quality mushrooms, although it may be mentioned that the quality produced by a high yielding strain (apart from the climatic conditions) often depends on the nutritional value of the compost and the grower's ability to control the number of pinheads formed for later maturing; for instance this can be regulated by means of the casing material, and with the same casing material by means of the watering technique during cropping. As an example, much water reduces the number of pinheads formed and gives better quality mushrooms. It must be emphasized, as has been proved many times—most recently by Mr. Bovenkerk in U.S.A.,—that the Alpha and Omega (for a given strain) is the amount of available mushroom nutrition in the finished compost (*i.e.*, after composting outside and in the beds); you get as many mushrooms as you can nourish. Some growers (most perhaps) are turning to less compost per unit area and shorter cropping time, and claim that they get a higher yield per ton of fresh material than with more compost per unit. That is undoubtedly true, but the real fact is, that with a thick bed of compost (including a longer cropping time) you get a higher yield, although in most cases not quite proportional to the amount of compost used. This is due to not quite optimal growing conditions: to wrongly prepared growing medium (known and unknown faults), to the general climatic conditions (controllable or not), to the casing material and related problems (watering technique and potential evaporation from the beds), pest and disease problems and many others. If all these "conditions" were 100% controlled the yield would be proportional to the amount of nutrition prepared (the amount of compost used)—but when a grower is far from these "100% conditions", he may easily find hardly any increase in yield with the same strain using 2 tons instead of 1 ton of compost per 100 sq. ft. The wise grower prepares compost and manages his growing-conditions so that he can get for instance, three crops a year giving, say, $3 \times 2.4 = 7.2$ lb. per sq. ft. per year—instead of 4 crops of 1.8 lb. = 7.2 lb. per sq. ft. per year.

I hope I may be forgiven when I postulate that the number of crops laid down per house per year in order to make a profit is related to the grower's ability—fewer crops indicate a better grower than more crops.

Years back most mushroom strains belonged to the slow producing type, whereas to-day there is a tendency for spawn producers to select fast-producing strains (not always high yielding strains) in order to suit growing systems with many crops a year. Generally speaking this means poor quality mushrooms. By using a fast producing strain on a thick bed (say 8 inches of compost) corresponding to 140 sq. ft. per

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ton of a 16-day fermented compost with supplements one often gets a high yield in the first three to four flushes (first month) and then the yield in the following two months is lower, sometimes giving a lower total yield than from a slow producing strain. An example is shown in Table 2.

TABLE 2

The Cropping Yield from a "slow" and a "fast" producing strain
Kilos per sq. m. in 90 picking days

	"Slow" strain	"Fast" strain
First 28 days	6.8 kg.	13.6 kg.
Next 28 days	7.4 kg.	2.7 kg.
Last 34 days	7.9 kg.	3.7 kg.
Total 90 days	22.1 kg.	20.0 kg.

The cause of this has not been thoroughly investigated, but it might be due to the mushroom producing a substance which, important for fructification, in too great quantities reduces the mycelium's ability to fruit. The large number of pinheads formed cannot be fed adequately for them all to grow big and of good quality, as the amount of nutrition available (which probably depends on an enzymatic reaction between the mycelium and the compost) cannot be produced as fast as it is wanted.

Conversely, in the slow producing strain the production of the "fruiting substance" is also slowed down causing a smaller number of mushrooms to form, the enzymatic reaction between mycelium and compost is sufficient to grow them of good quality, and as the fruiting substance does not increase sufficiently to become toxic to the mushroom, the formation of pinheads continues—and having sufficient nutrition in the compost, they grow well all through the three months. It must be added that such slow-producing strains sometimes continue to produce heavy crops in the fourth and perhaps in the fifth month of picking.

A further point about "slow" producing strains which may be mentioned, is that it has been proved experimentally that by adding certain amounts of supplements to the compost the yield with the same strain can be increased, and with too high concentrations of supplements the yield falls again; at the same time, as shown in Table 3, the yields produced in the three picking periods rise and fall in the same way.

It will be seen that non-supplemented compost gave 55% of the total yield in the first month, 24.6% in the second month and 20.4% of the total yield in the last month (34 days). Going as high as supplements called "Normal + 150%" ($N + 150\%$) it will be seen that 35% of the total yield is produced in the first month (28 days), 41.3% in the second month and 23.7% in the third month.

Unfortunately such an experiment was not carried out with other strains, but it would be interesting and valuable if this phenomenon also applies to other strains and especially to the "fast" producing ones.

TABLE 3

The effect on yield in the different picking periods when adding supplements to the compost. % of the total yield in the 3 picking periods (kilos per sq. m.)

Treatments	A	B	C	D
	without suppl.	N*	N+75%	N+150%
First 28 days	55.0% (9.4kg.)	50.7% (10.0kg.)	39.9% (10.5kg.)	35.0% (8.0kg.)
Next 28 ,,"	24.6% (4.2kg.)	29.0% (5.7kg.)	35.7% (9.5kg.)	41.3% (9.4kg.)
Last 34 ,,"	20.4% (3.5kg.)	20.3% (4.0kg.)	24.4% (6.4kg.)	23.7% (5.4kg.)
Total 90 days	100.0% (17.1kg.)	100.0% (19.7kg.)	100.0% (26.4kg.)	100.0% (22.8kg.)

N* = 4 kg. sulphate of ammonia at stacking
 15 kg CaCO_3 at 1 turn
 15 kg Gypsum } at 2 turns
 4 kg Superphosphate }

In four experiments carried out within two years with two different strains the following results were obtained:

TABLE 4

The results in yield with 2 different brown strains

Kilos per sq. m. in 90 picking-days from 18 cm. bed=80 kilos fermented compost per sq. m.

	Strain "X"	Strain "Y"
1 Exp.	21.9 kg	23.9 kg
2 Exp.	16.6 kg	23.1 kg
3 Exp.	18.7 kg	19.9 kg
4 Exp.	15.8 kg	23.0 kg
Average yield in 4 exp.	19.0 kg	22.5 kg

These experiments show that the two strains are different in yield and that x-strain is "slow" and y "fast". The x-strain gave the lowest yield but no necessarily because it was "slow". Of interest is the fact that x was not as constant in yield as y. The reduction tendency (Exp. 1 to 4) is evidently not due to growing conditions but lies in the strain itself. Such strains should not be marketed. A constant strain under constant conditions is most important.

I suggest that when the spawn producers prepare a certain strain from the original "mother material" that something like 5,000 cartons are made and kept in a cool store, that after a lapse of time some 5-10 cartons are selected at random and that subsequent tests should be on say up to 10 farms. When the reports are received from growers these should be analysed and then, and only then should the spawn be offered for general sale.

The strains in relation to quality:

"Small" mushrooms cause a big problem in many countries especially in the second and third flush. By "small" mushrooms I

mean that the fruit-bodies open too early. Taking into account that whether a mushroom opens or not depends on the time of picking it—from a theoretical point of view it would not be necessary to pick one open mushroom, if it were possible to watch it from hour to hour. Then all mushrooms could be first quality, if one considers first quality as closed mushrooms (apart from long stalks, soft tissue, etc.).

It is obvious that some strains under the same growing conditions have a tendency to open sooner than others, which must be considered a special strain problem. In general it can be said, that the "fast" producing strains open earlier (produce smaller mushrooms) than the "slower" strains.

It is however well-known that certain strains vary from crop to crop in regard to size of mushrooms. These variations seem often to be due to factors other than the strain itself, and often it is due to the amount of available "mushroom nutrition".

Table 5 shows an example with the same strain in two experiments; the average weight per mushroom (indicating the quality, as all mushrooms are picked closed) and the number of mushrooms picked are worked out.

TABLE 5

Two experiments with the same strain showing the total yields, the number of mushrooms picked in 90 cropping days, and the average weight in grams per mushroom

I Exp.	kg/m ²	No. of Mushrooms picked	Gram/Mushroom
First 28 days	11.53	13.25	8.7
Next 28 days	5.48	7.20	7.8
Last 34 days	6.84	7.86	8.7
Total 90 days	23.85	28.31	8.4 Average
II Exp.			
First 28 days	10.99	10.43	10.5
Next 28 days	5.48	5.86	9.3
Last 34 days	6.65	6.83	9.7
Total 90 days	23.12	23.12	10.0 Average

10—8.4=1.6 grams more per mushroom means much in size and quality. In this case it is evident that the difference lies either in the strain or was dependent on the "conditions" to form pinheads. In the first experiment 2,839 pinheads were formed and matured, in the second experiment only 2,312 were formed and matured, thus giving a better size. The available nutrition was probably not the cause of the differences in size, but was due to the strain's ability to use the nutrition.

In all experiments carried out at the Danish Mushroom Research Station (with 16 days outside composting and 48-60 hours pasteurization, with 1 ton of compost to 140 sq. ft. corresponding to about 7½ inch beds, and with three months picking and closed mushrooms) we have found

in most cases, whatever strain was used, that the average size in the first month was better than in the second month, but then the size improved again in the third month—sometimes being even better than in the first month. The cause for this last phenomenon is obvious because a smaller number of mushrooms are formed per sq. ft., thus leading to larger size.

In two experiments in which were tried two strains, a slow producing brown and a fast producing white strain, and in which the mushrooms were picked closed (Danish picking) and open (called English style) it was clearly shown that strains, as well as growing conditions and picking methods can be important. The results are shown in Table 6 and following remarks can be made.

TABLE 6

The effect on yield and weight of mushrooms picked in Danish style (closed mushrooms) and English style (open mushrooms) when using a "fast" white strain and a "slow" brown strain

I Exp.	White strain "fast"				Brown strain "slow"			
	English style		Danish style		English style		Danish style	
	gram/ kg/m ²	Mushr'ms	gram/ kg m ²	Mushr'ms	gram/ kg m ²	Mushr'ms	gram/ kg m ²	Mushr'ms
First 28 days	14.7	11.1	13.6	7.0	12.0	22.0	10.0	12.1
Next 28 days	2.7	14.4	2.7	6.2	2.9	18.6	4.0	10.8
Last 34 days	3.8	19.8	3.7	11.6	3.8	15.4	3.5	14.2
Total 90 days	21.2	12.4	20.0	9.8	18.7	19.0	17.5	12.1
 II Exp.								
First 28 days	11.3	8.4	11.8	7.2	7.9	27.9	5.0	11.7
Next 28 days	5.6	4.8	4.7	4.2	5.3	19.0	4.4	11.5
Last 34 days	2.2	5.8	2.5	7.7	5.4	15.3	4.3	10.2
Total 90 days	19.1	6.0	19.0	6.1	18.6	20.3	13.7	11.2

(a) The difference in the way the yield is produced between a fast and a slow strain is very obvious. The fast strain produces a very high yield in the first month followed by heavy reduction in the next two, whereas the slow strain gives a rather low yield in the first part and a proportionately higher yield in the last two months.

(b) Comparing sizes it is clear that the slow strain in each picking period and overall gives a much better quality than the fast strain.

(c) Although the slower strain in general produced a slightly lower yield, the quality was so much better as to fetch a higher market price.

(d) In the first experiment only a slight increase in yield was obtained by picking the mushrooms in English style. In the second experiment the same happened for the fast strain, but without increase in size. This was very interesting and supports the idea that the fast strain

"poisons" itself, as discussed earlier. With the slow strain however the English style of picking increased the yield very much and also the size.

(e) Discussing the growing conditions in general there is no doubt that these were best in the first experiment, giving both strains opportunity to develop normally, but showing that it is the total amount of nutrition in the compost which dictates the yield and not the method, but with the thought that the fast producing strain probably would have produced more in total if it had not acted as a "self-killer".

In the second experiment the growing conditions were in general worse (especially the nutritional value of the compost) except for the slow strain with English picking. The ability of this strain to form pinheads was rather poor, but when once established it was able to draw enough food from the compost for them to grow big and keep the necessary balance between compost and mycelium without poisoning itself. The Danish style of picking formed about the same number of pinheads, but did not get sufficient opportunity to grow big—thus giving a lower total yield.

It may be concluded from the two experiments that:

1. "fast" growing strains, under normal growing conditions, produce more pinheads than can be fed within the given length of time (between two flushes) thus giving poor quality, soon (after the three to four first flushes) followed by a reduction in pinheads formed and poisoning of the mycelium, causing difficulties in regard to the mycelium compost balance.

2. "slow" growing strains develop fewer pinheads (produce less "fruiting substance"), and keep a better mycelium/compost balance and do not cause severe poisoning. When the growing conditions are not quite optimum it pays to let the mushrooms grow bigger in order to obtain a higher yield, assuming that the bigger mushrooms can be sold as first quality.

These two experiments are very closely related to what is found on commercial mushroom farms.

The effects of peak-heating on yield with different strains:

In four experiments at the Danish Mushroom Research Station it has been shown that in order to obtain maximum yield (on horse manure compost prepared after the 16 days standard programme + supplements) surprisingly few hours of peak-heating are necessary. In Table 7 are shown the results from one of the experiments in which three different strains were tested. Groups of trays were taken from the peak-heating room after 0, 10, 20, 30, 40, 50 and 60 hours of steaming.

Apart from the very few hours of peak-heating necessary to obtain maximum yield (remembering that it is not unusual to give 7-10 days of pasteurization after 7 days composting in the United States) and recalling other experiments carried out at the D.M.R.S. which have shown clearly that by prolonging the peak-heating as long as 72 hours

TABLE 7

The effect of the lengths of peak-heating time on cropping yield with 3 different strains
Kilos per sq. m. in 90 picking days

<i>Number of "steaming" hours. (N.B. after about 22 hours of steaming peak-heating tempera- ture, 57-59° C. was reached)</i>	0	10	20	30	40	50	60
Strain X	7.3	9.5	15.5	16.6	17.2	15.7	16.2
Strain Y	10.4	10.3	17.0	17.6	16.6	17.0	
Strain Z	10.3	10.1	17.7	16.7	15.8		

of steaming, no reduction in yield was noticed, the above mentioned experiment shows that the three different strains used needed different periods of steaming in order to obtain maximum yield. These investigations need much more work, but it must be borne in mind that the different strains apparently do not need the same length of peak-heating.

Are the different strains more or less resistant to diseases or related problems?

It is often claimed that some strains are more easily infected with diseases (e.g., *Dactylium* and *Mycogone*) than others—and in some cases it is obvious. Some years ago the strain normally used in Denmark was never infected with *Mycogone* and was at that time considered resistant. When however new strains from abroad were introduced, these were often infected. Suddenly the previously resistant strain also became infected and since then it has always been susceptible. Unfortunately it could not be proved whether it was a change in the strain or a new strain of *Mycogone* which was the cause. By the way, the amount of infection always depends on the farm's hygiene programme; there are still old mushroom farms in Denmark where *Mycogone* has never been seen. But it would be valuable if the mushroom spawn producers would do some research on their selection of strains resistant to various diseases and insects.

At the D.M.R.S. it is clearly shown that some strains are more readily attacked by the severe *Trichoderma* sp. (the mycelium is killed in the casing layer) than others. Here again it is obvious that the number of infestations noted is many times greater with "fast" growing strains than "slow" growing strains with the same casing-material and compost type.

In two experiments in which three different strains were spawned in plots in a row on a shelf with two plots of strain x, then two plots of strain y and two plots of strain z, etc., and in which an attack of Mummy Disease started in strain y and spread rapidly in this y-plot, the Mummy did not spread to strain x and strain z. It has since been shown that if the Mummy Disease starts in strain x it does not spread to the other strains, and if it starts in strain z it does not spread to strain x and y. The attacks of Mummy, starting with each strain all seem to be different and do not attack the other strains. This phenomenon has led many commercial shelfgrowers to spawn now with 2 different

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With regard to Mat Disease (*Myceliophthora spp.*) it has been shown that the different strains are all more or less infected by "Mat"—but it seems that the "fast" producing strains show more resistance.

It has so far not been possible to prove anything definite about degeneration of strains. It is often claimed by commercial farms that a strain suddenly behaves in a way which could be attributed to degeneration (reduction in yields, deformations, etc.) and in some cases unfortunately this is certainly true; but until we have a special (perhaps international) mushroom spawn research station, it is doubtful whether we shall know much more about it. There are not many established tests for "degeneration" (in extenso) in mushroom strains. At D.M.R.S. work has been carried out for 2-3 years about the phenomenon "hard-gilled" or "open-veil" mushrooms.

It was first proved with certain strains, that when "hard-gilled" mushrooms appeared in the culture, this was followed by severe reduction in cropping yield. Some results are shown in Table 8.

TABLE 8
The effect of "hard-gilled" mushrooms on the yields
Grams of mushrooms per plot (sq. meter)
 () = the date on which the hard-gilled mushrooms were observed

Shelves: Experiment plot	hard-gilled 16	normal 30	hard-gilled 17	normal 3	hard-gilled 18	normal 4
from 0-14 days	4392	5384	3690	3095	2021	4042
" 14-28 "	7164	5083	6427	7426	6249	4361
" 28-42 days	1198 (10/8)	4374	5402 (12/8)	6036	6745	7613
" 42-56 "	456	1768	510	2145	1719 (21/8)	3217
" 56-70 "	1043	2584	1402	6250	1708	2207
" 70-90 days	1773	2285	2303	3524	2450	4122
TOTAL	16,026	21,478	19,734	28,476	20,890	25,562
Trays: Experiment plot	80	21	8	85	68	11
from 0-14 days	5660	3768	2110	3958	3258	3116
" 14-28 "	2002 (30/7)	7778	4114	4304	5598	7510
" 28-42 "	—	2562	5990 (18/8)	8076	4206 (21/8)	2966
" 42-56 ..	1044	2342	898	3680	466	4282
" 56-70 ..	3190	1180	1112	3228	76	2080
" 70-90 ..	938	2012	5818	1900	2328	3414
TOTAL	12,834	19,642	20,024	24,646	15,932	23,268

It is obvious that strains producing these specimens give reduced yields. In the 1954 strain experiments mentioned earlier it was also seen that all the low-yielding strains in general produced hard-gilled mushrooms. Until now the growing conditions have been considered

responsible for the appearance of hard-gilled mushrooms, but according to the investigations carried out at D.M.R.S., it seems that the cause lies within the strain itself. Some strains produce these more often than others, and we know strains which never produce hard-gilled mushrooms and which in general produce high yields. According to these investigations it was shown, that if a sporeprint was taken from a strain producing hard-gilled mushrooms, the spawn made from it also gave hard-gilled mushrooms and reduced yield in the following crop, but by selecting and testing it was also shown, that **hard-gill free** "under-strains" could be obtained. This is only one example showing degeneration phenomena and one which is easy to see, but the big question is whether other signs of degeneration could be observed by close attention and investigations and whether in such a way we could isolate the type of strain we want.

Why and how to test strains on commercial farms:

As long as we do not know more about strains, it is extremely important for the practical grower always to be familiar with what is on the market and to run continuous tests. It is well known that a strain may suddenly change in ability to produce normal yields and also gradually produces declining yields over a number of crops, which may be even worse. It is therefore necessary for the individual grower to carry out reliable tests under his own conditions. The grower who tries 10 different strains will in most cases get 10 different results. The tests must be carried out in plots, e.g., 50 sq. ft. each and with 2-3 sets of plots and in the same house and with the same compost and the daily crops must be weighed. It is not possible to judge the yield, merely by looking at the beds, over a cropping period of 2-3 months. One may misjudge by as much as $\frac{3}{4}$ lb./sq. ft. It seems to be too big a job for the practical grower, but I dare to say that the extra expense will be returned many times.

After selecting one or two strains which suit one in shape, colour, yield and quality, etc., from several tests, one must not forget to run continuous small scale tests with the "standard" strains together with all new strains. These results will reveal far more than might be expected. Finally it is our experience, that if 10 different strains are tested without showing much difference in yield, **and if the yields are on the low side** (1.2—1.6 lb. per sq. ft.) in most cases this is due to the growing conditions, which should therefore be altered.

Discussion:

After 6 years of experimental work with mushroom problems in general it may be emphasised that although very big variations in yields with a given strain can be obtained by altering the growing conditions (and especially by going to extremes) and the behaviour of many individual strains seems to be affected by the growing conditions (air conditions, compost, peak-heat, casing, etc.) it is evident that the difference in yielding-capacity and behaviour between strains may be a more difficult problem. It is true that mono-spore cultures can be made, from which not one single mushroom can be produced. This shows that although the mushroom strain is only one factor of the

many incorporated in the total growing process it is at least **one single factor**, which should be the subject of more research than is being done at present. The research should take care of basic problems, selecting and testing, trying to keep certain strains more constant, giving much more detailed information about requirements, etc. Until we know more about strains it may be suggested that all experimental work all over the world at the established mushroom research centres, mainly devoted to problems other than strain-problems, is not of much value as long as the " heart " of the growing (namely the mushroom strain) is not a constant and more or less controllable factor. Frankly speaking it is true to-day that all experiments carried out really only apply to the particular strain which was used in the past, which again means, that the results cannot be applied to all the other strains and must be proved for them by further experiments—this means much unnecessary work and involves big expense.

Therefore what is needed to-day is the establishment of a Mushroom Spawn Research Station, either a national or an international one. Then the established research stations, working on other problems, could work more safely. All growers and spawn producers in Europe should join together and find the money to set up an international spawn research station, from which both growers and spawn producers could get help.

It is true that spawn producers carry out much investigation, but not enough. Perhaps it can not be expected, as establishment of such a research centre costs more money than a single producer can afford. Of course such a programme is not favourably viewed by certain spawn producers, but this should not keep the rest of them, nor the growers, joining together. The last resort could however always be to put up an " International Mushroom Spawn Research Station " plus factory, delivering spawn to those interested, and in this way help to pay the expenses of the research department.



THIS MAKES US FLUSH

" Bill " Sandford's lively and informed " Bushel Box " in the January 19th issue of the " Fruit and Flower Trades Journal " contained the following :— Although the **Mushroom Growers Association** refers to itself as a specialist branch of the N.F.U., I would like to repeat the rider which I have made on previous occasions, that it is also certainly the most progressive and alert. Latest news I have had from this bright body is that a fund has been opened in London for the dependents of the 18 people killed in the Belgium Mushroom Farm Disaster just prior to Christmas. Another snippet is that **Sir William Slater, K.B.E.**, Secretary of the Agricultural Research Council, will be the Guest of Honour at the A.G.M. at the Connaught Rooms on Tuesday, 24th March.

MORE MUSHROOMS PER SQUARE FOOT!

January 2nd, 1959

The house in question was planted on August 27th, and the first pick was on September 29th. The house is of 1,030 sq. ft.

In eleven weeks from the first pick it had produced 5,261 lbs. or 5.10 lbs. sq. ft., and as we wished to avoid composting over the Christmas period, it was allowed to run a fortnight longer than usual whereupon the ultimate figures were 5,775 lbs., or 5.60 lbs. sq. ft.

It is possible that these figures (which include stalks) may not be believed by some but I assure you that they are quite accurate and truthful, and you are welcome to examine my records if you wish.

In support of the above, the figures of the remaining five houses (all planted with 100% Spawn) which are in crop at the moment, are as follows:-

11 weeks	- 3.93	lbs. sq. ft.
9 "	- 3.64	" "
7 "	- 3.24	" "
2 "	- 1.92	" "
1 "	- .81	" "

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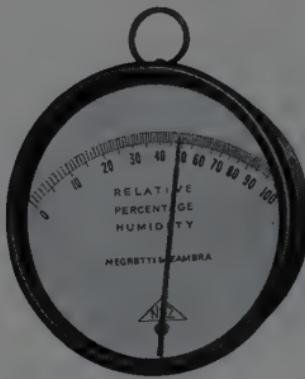


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New Book

"THIS MUSHROOM BUSINESS"

(By FRED. C. ATKINS)

Reviewed by SIR WILLIAM SLATER, K.B.E., D.Sc., F.R.I.C., F.R.S.
Secretary, Agricultural Research Council

Mr. Atkins's earlier book "Mushroom Growing To-day" is so well known to mushroom growers that a new book from him is sure to be widely welcomed. "This Mushroom Business" tells the story of post-war developments in the mushroom industry; I almost said "tells the **inside** story" for Mr. Atkins has played a leading part in many of the activities he describes. His method is to take extracts from articles written since 1945 for various periodicals and to connect them together in narrative form. This has given a vividness to his story that could hardly have been attained in any other way.

Mushrooms as a crop are exceptionally sensitive to environmental conditions and also subject to a wide range of diseases. They are also very perishable and they can scarcely be described as a staple article of diet. Mr. Atkins has clearly seen the implications of all this—both the opportunities for further research on production and diseases and the need for continued publicity to promote sales. He has not only been a fervent advocate of co-operation among mushroom growers to attain these ends, but has himself done much to put his principles into practice.

The book begins by describing the formation of the Mushroom Growers' Association and the efforts that were put into the establishment of the Yaxley Research Station, which in the comparatively few years of its existence did such valuable work under its Director, Dr. R. L. Edwards. However, research is an expensive business and, with falling prices for mushrooms, subscriptions dwindled until eventually the Yaxley Station had to close and responsibility for mushroom research was taken over by the Glasshouse Crops Research Institute at Rustington, near Littlehampton.

The main thing for which the Yaxley Station will be remembered is its production of a formula for synthetic compost, using wheat straw and a mixed chemical activator. The adjacent firm of Noble Mushrooms Ltd. took it up and demonstrated that it was a completely satisfactory substitute for horse manure. Some of the problems that arose in developing it are described in one of the early chapters. There are also references to other work at the Station, including work on casing soils, and pests and diseases.

A curious feature in mushroom growing is the way in which different pests and diseases become prevalent in widely separated parts of the country in different years. One chapter is entitled the "Dactylum Year" (1951) and later other years are described which might just as well have been called the "Cecid Year" (1956) or the "La France Year" (1957). One of the main tasks for future research must be to work out in what way these upsurges of particular pests and diseases are related to environmental conditions. This will be no easy task and will demand closer and closer control of every factor in the growth of

the mushrooms. However, there is little doubt that perseverance and patient work by mycologists and entomologists will eventually be rewarded with success.

Mr. Atkins shows himself very much alive to all these problems. He has been in the business long enough to enable him to take a perspective view that would be impossible for the newcomer. "We are being driven, against our wills", he says "to do certain things, chief of which is to crop for no longer than about 6 weeks . . . Not so very long ago we could pick for 16 weeks if we wished. Cropping was slower and disease was less virulent." It is this long-term view of what has been happening in the industry, evident in other parts of the book besides those on pests and diseases, that makes Mr. Atkins's story such an interesting one.

It is obvious throughout the book that Mr. Atkins is a strong supporter of more research and experiment. For years he has done his best to encourage investigations on every aspect of production and when the Yaxley Station closed down he organized a Research Committee of the Mushroom Growers' Association which gives valuable help to the workers now developing mushroom research at the Glasshouse Crops Research Institute. Mr. Atkins has recognized also that a valuable stimulus to research is given by periodic meetings of interested research workers and growers and he has accordingly taken an active part, with others, in organizing four international conferences on mushroom science. These have attracted research workers and growers from many European countries and even some from America.

There can be few aspects of mushroom culture on which Mr. Atkins has not some stimulating comment to make. Although his own firm grows mushrooms on the shelf system his comments on the possibilities of considerably increased mechanization of the tray system show that he is always thinking ahead. This, together with speculations on possible future developments in continuous mechanical composting, leads him to the conclusion that the industry is dangerously under-capitalized. It seems natural, therefore, that he should conclude with a chapter of "Advice to the Newcomer", in which he emphasizes that mushroom growing to-day has become a very serious business, not to be embarked upon lightly. The newcomer would be foolish who did not weigh up carefully the points Mr. Atkins has made from his long experience.

Although much of this material has already appeared in print in scattered articles, its collection in this book provides a survey of developments in the industry over the past twelve years which makes interesting reading and which will no doubt help to channel future effort along the most useful lines.

"**THIS MUSHROOM BUSINESS**" is published by FABER & FABER at 18/- and is available from the MGA Office—plus 1/- postage.

MUSHROOMS ON TELEVISION

The programme has now been prepared in connection with the Television advertising of mushrooms, to take place from the Birmingham studios of I.T.V. during the coming summer months.

Commencing on Sunday, 10th May, there will be no fewer than 55 seven-second references to mushrooms to make a total time on the air of six and a half minutes.

The overall programme will consist of three separate films giving seven seconds of visual and five seconds of speech.

One film will feature eggs, mushrooms and bacon, a second film will deal with steak and mushrooms and a third will show mushrooms on toast.

It was only after long discussion and on expert advice that a decision was reached to try and put mushrooms over in the easiest possible form and most members will agree that the three dishes featured are, in fact, mushrooms in simple, easy-to-prepare form.

Each film will cost about £60 to make and each showing on television involves a charge of £65 or £70 with the exception of Saturdays when the cost drops to £55.

The total cost therefore involved is approximately £4,000 to the Association, an expenditure only made possible by these members who so loyally support the Publicity Fund.

After a detailed discussion the Publicity Committee have agreed that this experiment in television advertising can only be assessed at its true value if, in fact, it stands alone. In other words no other advertising aids are planned to support television on this occasion.

In order to measure the success or otherwise of this campaign a survey of greengrowers in the area concerned will be made both before and after the campaign.

From the Birmingham studios this mushroom message will go into a million homes with a maximum potential adult audience of three million people.

Throughout the campaign the emphasis, both in visual and sound, will be on mushrooms, playing all the time on the MGA publicity gimmick of "M-M-M-Mushrooms!"

These mushroom programmes will go out on the following dates:—
10, 11, 12, 14, 15, 16, 18, 19, 20, 21, 22, 23, 24, 26, 28 and 30th May,
1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29 June, 1, 3, 5, 7, 9, 11, 13,
15, 17, 19, 21, 23, 25, 27, 29, 31 July, 2, 4, 6, 8, 10, 12 and 14th August.

It will be seen that the period so covered is that when in previous years mushrooms, generally speaking, have made their lowest prices of the year.

Each mushroom publicity flash will occupy a place in the Supermarket or Market place programme and these programmes usually go on the air between 6.30 and 7 p.m. or between 10 p.m. and 11 p.m.

You can make better compost more quickly and reliably-with **ADCO 'M'**

**SPECIAL MUSHROOM COMPOST ACTIVATOR GIVES
HIGHER FERMENTATION TEMPERATURES, AND A FIRST
CLASS COMPOST THAT ASSISTS THE SPAWN RUN**

MANY ADVANTAGES are gained by using Adco "M" as an activator in composting. Chief among them is the higher temperature attained both in the compost heap and in the beds during the peak heating process. Look at the results that follow from these higher temperatures.

First of all, fermentation goes ahead at a faster rate. Composting takes less time and the finished product is ready earlier.

Secondly, you have greater assurance that your crop will be free of pests and disease. The higher temperature either kills off the pests inside the heap or drives them to the surface, where they can be dealt with by insecticides. High temperatures during fermentation are particularly vital in preventing disease such as Vert-de-gris, of which there is special danger when composting during the winter months.

More nourishment

If you use Racing Stable manure, or other manure in which excess straw is present, the use of Adco "M" is strongly advised. The fermentation of this type of manure takes place more rapidly and effectively when Adco "M" is added. You get a more thorough breakdown of the strawy material, which then becomes available as food for the growing spawn. So your compost provides more nourishment for the mushrooms, and you get a bigger crop.

Better spawn run

Adco "M" produces a good quality compost of even texture. It provides an

ideal medium for spawn run and helps to avoid greasy conditions, lack of aeration, and over wet compost - all of which delay mycelium growth. The spawn is able to make more rapid use of the food provided. It establishes itself more quickly and this is again a great help in preventing diseases and weed fungi. The faster the spawn grows and fills the compost the less likelihood is there of disease and weed fungi becoming serious competitors. A quick spawn growth also gives a quicker ultimate production.

You can have freedom from uncertainty in the composting process - by using Adco "M". It will pay you hands down. Adco "M" is specially formulated as a result of years of experiment, for the specific purpose of making mushroom compost. It can be used for composting with straw alone, if you wish. Or it can be used to compensate for variations in the quality and texture of your manure supply. Adco "M" provides the way to better mushroom compost every time.

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It should be realised that this is an advertising campaign as opposed to a sales promotion campaign and, because of this and the expense limitations it was decided, on expert advice, not to attempt, this time at any rate, to popularise raw mushrooms in salads.

WORLD'S PRESS DIGEST

The large quantities of mushrooms hardly sold at all. (*Nurseryman Seedsman*, January 1/59). Heavy arrivals of mushrooms caused demand to fall off, producing some of the lowest prices of the season. (*Commercial Grower*, January 2/59). Obviously this week the public are not mushroom-minded, and heavier supplies which have been coming forward during the past week have depressed prices considerably. (*Fruit Trades' Journal*, January 3/59). Smaller consignments were more in demand than of late. (*Nurseryman Seedsman*, January 8/59). The slight lift in mushrooms last week had fallen away and heavy quantities hung fire. (*Nurseryman Seedsman*, January 15/59). Trade remains steady although prices are not quite so high as last week. (*Fruit Trades' Journal*, January 17/59). Mushrooms arrived in very heavy quantities but most hung fire. (*Nurseryman Seedsman*, January 29/59). Colder weather had its effect on the mushroom trade; only small quantities have come forward and prices tend to be firm on the whole. (*Fruit Trades' Journal*, January 31/59).

The competition among canners and freezers is building up fast. Unless the grower has a cast-iron national organisation to organise for him, he is going to take the brunt of all the price cuts in the shop war. The time for fast thinking and fast action has arrived.

(*Grower*, January 24/59).

Good thermal insulation and clarity of vision under varying temperatures and humidities are advantages claimed by double-seal window units made by Multiglass Ltd. Two panes of glass separated by an air space in which dehydrated air is hermetically sealed are the basis of double glazing. Multiglass units are made to customers' sizes with cavity widths varying from $\frac{1}{8}$ to $\frac{1}{2}$ inch. (Scope, February /59).

The passenger train services at Yaxley railway station are to be withdrawn. At Yaxley there was a busy mushroom-growing industry which had formerly relied on passenger train services. Mr. G. F. Huskisson, traffic manager, Kings Cross, said additional accommodation had been provided at Peterborough so that they could give the mushroom growers just as good a service. The growers would continue to take mushrooms to Yaxley station, but they would go by road to Peterborough instead of by rail. (*Hunts. Post*, January 15/59).

The mushroom growers in Yorkshire are well into the main cropping season, with less disease reported and weights and quality are really first-class.

East Riding correspondent, *Commercial Grower*, January 23/59).

New Chairman of the Worthing and West Sussex Growers is Mr. Norman Liverman, J.P., of Littlehampton, a sweet pea specialist. He succeeds Mr. D. G. Frampton.

(*Fruit Trades' Journal*, January 24/59).

The coal industry is in difficulties. May be, as the industry moves out, horticulture will move in. We have yet to hear of mushrooms being grown in a disused coal mine, but stranger things have happened. Rhubarb forcing too, might be an alternative crop. We may yet have the Spent Main Mushroom and Rhubarb Colliery!

(*Commercial Grower*, January 16/59).

The longer you keep your chickens from laying eggs, the better their egg production will be. That is the conclusion indicated by recent research at the Agricultural Department of Reading University.

Anthony Smith in *Daily Telegraph*, January 26/59.

Mushrooms—no longer a luxury food in the United States—are adding flavour and essential vitamins to the American national diet. At least 85 millions pounds of the delectable fungus are now grown in the U.S. each year, with a return of over 30 million dollars at the retail stores. Over the past 25 years yields have increased from about one pound to two pounds per square foot of bed area, and commercial production has more than doubled. It is now big business, capitalised at over 50 million dollars. Per capita annual consumption is less than 0.5 pounds and fresh consumption only about 0.16. By comparison, consumption of mushrooms in England is near 1 lb.

(*Commercial Grower*, January 16/59).

If this £7,500,000 grant to horticulture is spread over the next five years distributed among this section fairly evenly, the whole grandiose scheme becomes nonsense, firstly because it represents the pathetic figure of £30 per grower per year, and secondly because there are a lot of the fraternity who could best serve horticulture by going bankrupt and getting out of it altogether, so that any money given to them is only wasted.

Alec Blache in *Fruit Trades' Journal*, January 31/59.

Possibly the government hoped to smooth NFU feelings by tying-up the new grants scheme in rejected-tariff ribbons. It has had just the reverse effect. What delights us is that the Union has at least been goaded into a fighting attitude, of obvious determination to engage in battle, rather than to lurk in a mood of sullen defiance... Getting domestic problems into line with international trends is a tricky business, liable to spell trouble for any government.

Commercial Grower, January 30/59.

One criticism of the Linfield manure turner levelled from the U.S.A., where four of the machines are now in operation, was that it could not stack the synthetic material used at the initial stage. The piles had

to be hand built first. The new adaptations overcome that problem, and the introduction of a second roller at the top of the conveyor also levels out any lumps and ensures even watering. The cost of the basic machine is approximately £5,100. The model with the second roller and other modifications, which is also slightly wider to allow for American conditions, is priced in the region of £6,000.

Commercial Grower, January 30/59.

The production of mushrooms in Holland has increased steadily from an annual quantity of 70,000 kilos in 1943 to more than 1,500,000 kilos in 1958. More than two-thirds is exported. In 1958 the export value amounted to over £300,000. Domestic consumption is increasing but is low compared with other countries. *Grower*, January 31/59.

JOHN H. D. RODWELL

A well-known figure in the mushroom industry of this country, Mr. John H. D. Rodwell, who has been for four years with the firm of S. A. F. Sampson Ltd., Oving, Chichester, Sussex, is to leave the mushroom industry this month and return to an earlier love—that of a schoolmaster. He is to join his father-in-law, Mr. Geoffrey W. Shilcock, as Headmaster of Westbourne House, a prep. school at Shopwyke, Chichester. At the same time he will also be running a farming estate of some 80 acres.

Mr. Rodwell won a scholarship to Bradfield College and in 1942 became an articled clerk to a firm of solicitors—his father is a solicitor with business in Piccadilly, London. It was at about this time that he played for the Corinthian Casuals Football Club. As soon as he was old enough he became a fighter pilot with the Fleet Air Arm.

After the war he returned to the law and studied at the Bar in preparation for the Colonial Service—he intended to settle in South Africa. Whilst waiting to take up an appointment he filled in time with the teaching profession and married—his wife is a sister of Anne Shilcock, the well-known lawn tennis player.

The arrival of twin daughters and his enjoyment for teaching decided Mr. Rodwell to give up his plans with the Colonial Service. After the war he became a Founder-Member of the R.N.V.R. Air Squadrons, flying firstly fighter and anti-submarine aircraft and eventually helicopters, becoming the only R.N.V.R. helicopter in the country, operating with the Air/Sea Rescue Unit at Ford, Sussex. Now that



the Air Divisions have been expanded he is a Lt. Commander with Naval Intelligence. He was about to become a commercial test pilot in helicopters when he joined the Mushroom Industry. During his four years he became Mr. Sampson's right-hand man, both at the mushroom farm at Chichester and at the spawn distributing centre.

Mr. Rodwell, when he joins his father-in-law in partnership at the preparatory school, will leave behind him many friends in the mushroom industry. He now has four children, three girls and an eight-month-old son.



IS 4·1 LB. PER SQ. FT. POSSIBLE?

Yes, it most certainly is for in some preliminary tests at the Danish Mushroom Research Station at Copenhagen, concerned with the influence of the depth of the compost in relation to the air/bed ratio and recirculation of air, 20.1 kilos of mushrooms per sq. meter, (4.1 lb. per sq. ft.), were harvested in the first 28 days of picking. This total included stalks but deducting these, the average per sq. ft. in just four weeks of pickings was 3.28 lb. These were all closed mushrooms and the average weight per mushroom, including stalk, was 10 grams.

Full details of this experiment are to be given at the 4th International Mushroom Congress at Copenhagen next July.

1959 PUBLICITY FUND CONTRIBUTORS

Dan Wuille & Co. Ltd., Covent Garden Market, W.C.2	..	..	100	0	0
Francis Nicholls Ltd., Smithfield Market, Birmingham	..	..	157	10	0
R. E. Jenkinson Ltd., Covent Garden Market, W.C.2	..	..	105	0	0
Wm. Morgan & Co. Ltd., Salesmen, Custom House Street, Cardiff	..	..	10	10	0
Ernest White Ltd., Salesmen, Kirkgate Market, Leeds	..	..	5	0	0
C. W. Tooley & Son Ltd., Salesmen, Nottingham	..	..	2	2	0
Geo. Jackson & Co. Ltd., Smithfield Market, Birmingham	..	..	50	0	0
Ed. H. Lewis & Sons Ltd., Covent Garden Market, W.C.2	..	..	5	5	0
Wm. McGrattan & Sons Ltd., Smithfield Market, Manchester	5	5	0
G. W. Jackson (Cardiff) Ltd., 11 Custom House Street, Cardiff	10	10	0
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COPENHAGEN, JULY 18-21, 1959

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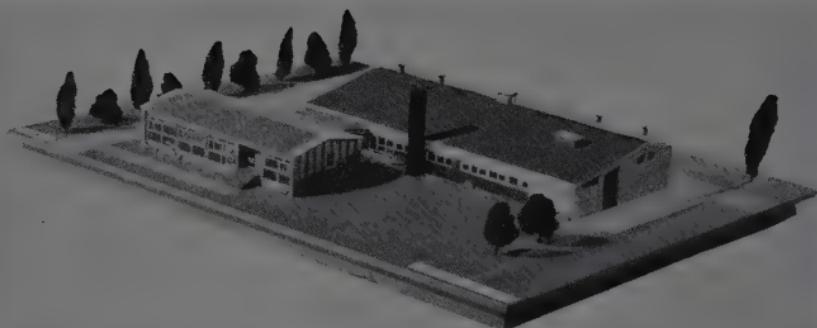
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The Dutch Mushroom Research Station is nearing completion. The picture here is of a model of the station. Dr. P. Bels, well-known in England, is the station's energetic Director

20-year old Miss Ann Pascoe, who is settling down in Agriculture House as the MGA's Public Relations Officer.

She had previously spent several years in journalism.



Pictures we couldn't find space for before. The two below were taken at the farm walk near Blackpool where the Mereside Mushroom Co. (Mr. Frank Bleazard MGA Chairman) were hosts.



Great News for Mushroom Growers!

DITHANE DUST

TRADE MARK OF ROHM & HAAS COMPANY, PHILADELPHIA.

Controls deadly diseases

Dactylium (Cobweb) and Mycogone (Bubble), serious and prevalent mushroom diseases, are now being effectively controlled. P.B.I. Dithane Dust, containing 20% Dithane—the most widely used fungicidal material in the world—is increasingly employed for the successful control of these two deadly mushroom diseases, **and for the control of Verticillium and Red Geotrichum**. Safeguard your mushroom crops this season and every season with multi-purpose Dithane Dust.

And these Aerocides control Mushroom Flies.

BHC (Lindane) and Malathion.

Also from P.B.I., originators of the Aerocide Process, come two important Aerocides, providing the most economical and efficient control of mushroom flies. Ask for them by name—**P.B.I. Aerocide B.H.C. (Lindane) and Aerocide Malathion**. You can use them through the famous P.B.I. Aerocide Projector, Microsol Generator or Compressor/Spray Gun Outfit.



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GCRI ANNUAL REPORT, 1957

This Report follows the practice usual for such Research Stations, of describing the work in progress in a Summary of Research, while fuller details are given in separate articles by the various research workers.

In the first of these P. B. Flegg describes experiments in which the addition of dried compost to the casing (soil or peat and chalk) produced small but significant increases in yield. Addition of peat to soil casing increased the number of mushrooms, but not the yield. When cane sugar and urea were added to the casing, increasing the quantities added, delayed fruiting and diminished the yield. There was less effect when these nutrients were added later, up to 11 weeks after casing.

Preliminary experiments are reported on the effect of soluble salts in compost and casing on the growth of mushroom mycelium and on fruiting.

Miss D. G. Gandy, in a detailed comparison of symptoms observed during recent outbreaks of disease (under such names as "Brown Disease" and "Watery Stipe"), with those described as characteristic of Mummy, La France, and Damping-off diseases, shows that each of the symptoms is found in more than one of these diseases, and the collective symptoms of any one outbreak do not exactly correspond with those of any one disease. In cropping experiments with infected material, no characteristic symptoms were reproduced, but yields were very low and in other experiments the rate of mycelial growth was subnormal.

N. W. Hussey and I. J. Wyatt report on the insects found in horse manure at various times of the year. They have found an eelworm parasitic on phorid flies, which greatly reduces their fertility. Experiments on cecid larvae are also reported, showing *inter alia* that the two main species are killed at 113° and 99° F.

Growers who are interested in an early peep at future developments will find these reports well worth reading; those who only want practical directions for immediate use may wait until these appear in the MGA Bulletin.

Much work on other glasshouse crops and their pests and diseases is also reported, but the mushroom crop is clearly not the Cinderella it used to be.

RLE

BELGIAN DISASTER FUND

The fund launched by the MGA for the relief of distress amongst the dependents of those who lost their lives in the Belgian mushroom mine disaster, just before Christmas, has reached over £400, with contributions coming from over a wide area including Scandinavia, Europe, America and South Africa. The fund will close on 31st March.

MARCH CALYPSO

We spot-light things you ought to know
In this month's topical Calypso.
Spawning Rate—the area you put a quart in—
Was once sixty square feet per carton;
But now the day is fastly dawning
When growers all will be Double Spawning.
It has been proved, the experts claim,
That quite one-fifth would be the gain.
To Calculate what this can bring
Is bound to make the changes ring;
It raises two-and-a-half pounds up to three,
An astonishing increase you will agree.
That's ten three-pound chips so easily earned
Per sixty square feet Doubly Spawned;
The extra expense when all is told,
Is thus re-couped by quite ten-fold.
Yes! We spot-light things you ought to know
In this month's topical Calypso

F.P.

CORRESPONDENCE :

NO RESTRICTIONS PLEASE

At the Bournemouth Exhibition in October it got around on the evening of the last day that the Open Competitions for mushrooms might, in future, be somewhat confined to exclude successful competitors of previous years. While Open Classes remain such they set a very high challenge indeed and should encourage growers everywhere to have repeated the comment which appeared in the November Bulletin "without question the standard of quality and that of display set a new high level".

At an exhibition attracting so many international visitors it is surely desirable to go on setting higher and higher levels year after year, regardless of the fact that certain growers have been able to win the trophies many times in succession. Once an Open Class becomes a "Confined Class" it loses its value and attraction. The one and only class which was confined at Bournemouth had only one exhibit staged and it would be hard to believe that members generally would wish to see other classes heading in this farcical direction.

We trust that the Committee dealing with these matters will give the matter considerable thought before agreeing to any changes in the present rules. It is so easy to take a retrograde step in these matters and then regret it afterwards. We would advocate sticking to the old adage which says "leave well enough alone".

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C. Snowdon & Co. Ltd., Castlefolds Market, Sheffield, 1	4	13	0

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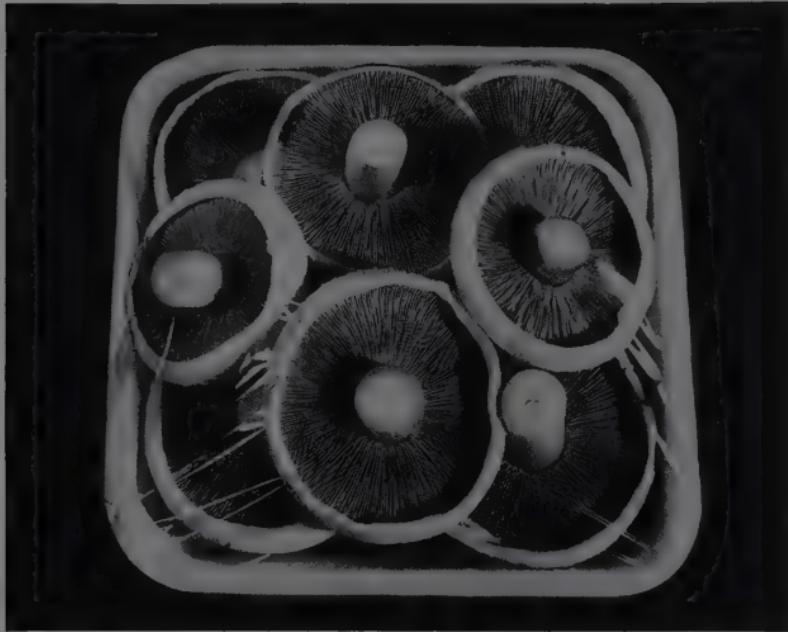
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Previous contributions already acknowledged.

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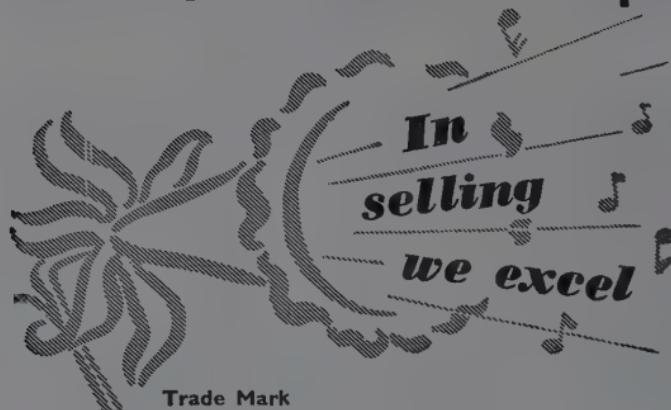
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